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Processing Cabbage Germplasm Evaluation Results in 1999

Information on the Effects of Planting Date and Genotype on Processing Cabbage Yield and Head Traits in Ohio in 1999

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Seed for the genotypes tested in these studies was provided by:

Bejo

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Petoseed

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Project Summary

Fourteen varieties and experimental lines of processing cabbage were planted on May 11 and June 18, 1999 at the Vegetable Crops Research Branch in Fremont, OH. Plots of each entry were replicated four times per planting date and arranged in randomized complete block design, including planting date as a replication and design factor. Transplants were set into each plot, consisting of two rows spaced at 30 inches and with 18 inches between plants. Entries were harvested when mature. The total and individual weight of ten heads per plot were recorded. The weight, size (polar and equatorial diameter), and core dimensions were recorded on five individual heads per plot. Subjective estimates of head density, internal color, and other traits were also made at harvest.

Overall, planting on June 18 led to slightly smaller heads with smaller cores than planting on May 11. Estimated yield (marketable, non-marketable), core base width, and the percent of the head volume occupied by the core were impacted by the interaction of genotype (E) and planting date (PD). Influences of PD and E on total yield, head dimensions, and core length were independent. Estimated yield was lower in the June planting compared to the May planting. But, the magnitude of the reduction in yield with June planting varied among genotypes. Planting in June versus May significantly changed at least five of eight head and core traits evaluated statistically in three genotypes. In contrast, planting in June versus May significantly changed 0-1 of eight head and core traits evaluated statistically in two genotypes. Taken together, these data may assist growers in matching varieties and planting dates more successfully.

Introduction

Variety selection is an important management decision. The need to meet harvest schedules (often through sequential plantings) complicates variety selection in processing cabbage production. Research-based information on how a variety responds to changes in planting date, for example, may assist growers in identifying varieties largely unaffected by planting date or in selecting varieties specifically for early or late planting.

Project Goals

The primary goal of these studies was to develop information useful to Ohio growers and processors in selecting varieties, especially for different planting periods. These studies were also designed to help explain how the interaction between genotype and growing environment impacts specific crop traits.

To accomplish these goals, we planted a wide assortment of processing cabbage varieties and experimental lines in fully replicated plots in May and June. Yield and physical external and internal head traits were recorded.

Materials and Methods

Transplant Production. Entries were solicited from cooperating seed companies in winter 1998-99. Transplants were seeded in early spring, allowed to develop 2-4 true leaves in the greenhouse, and hardened-off before planting into the field.

Plot Establishment. A randomized complete block design was used. The experiment contained four replications per entry per planting, two planting dates (May 11, June 18), and fourteen entries. The two-row plots were established with a cone-type two-row transplanter. Each row was 30 ft. long (each row containing approx. 20 plants), with 30 in. between rows and 18 in. between transplants. A 0-46-0 fertilizer was used to supply 60 lb. P_2O_5 and a 0-0-60 fertilizer was used to supply 250 lb. K_2O in September 1998. Ammonium nitrate was broadcast to supply 70 lb N/A on May 1, 1999. A nutrient starter solution (0.7 qt. 10-34-0/50 gal. water) was delivered next to the transplants.

Plot Maintenance. Dead transplants were replaced (if possible) within one week of initial planting. Standard pest management strategies based on scouting, thresholds, and application of labeled pesticides were employed. Irrigation was applied on July 1 (0.10 in.) and July 16 (0.5 in.). Climatic data for the study are shown in Table 2.

Data Collection (Field). Plots were reviewed two-three times weekly to assess development. Notes on plant stature, head shape, and other traits were taken on mature entries immediately prior to harvest.

Data Collection (at Harvest). Harvest readiness for individual entries was estimated from published maturity information and visual examination of the five plots per entry. At maturity, ten consecutive heads were removed from both rows in each plot. These twenty heads were weighed untrimmed in the field as a group and after sorting as marketable, split, or rotten. Ten marketable heads were then selected at random for further evaluation. The heads were labeled and weighed individually. Thereafter, heads 1-5 were trimmed (five outer leaves removed) and measured for size. The polar and equatorial diameter of each whole head were recorded. Heads were then cut in half longitudinally and the core length and base width recorded. Therefore, for each entry, the weight, polar diameter, equatorial diameter, core length, and core base width were measured on twenty individual heads. Because entire plots were not harvested, yield (ton/A) was estimated by assuming a plant density of 11,616 plants/A. Yield (ton/A) was then calculated based on measurements taken on the ten consecutive heads removed from each plot.

Statistical Analysis. Head density was estimated at harvest and through calculation using replicate averages of head weight and polar diameter. Likewise, the percent of the head volume contained in the core was estimated through calculation using replicate averages of head polar diameter and core length and base width. Replicate averages were calculated and used in means analysis. Main effects and interactions of planting date, entry, and replicate were analyzed with fully specified model statements in SAS (alpha = 0.10). Fisher's Least Significant Difference test (alpha = 0.10) was used to analyze the effect of planting date and replicate while Duncan's Multiple Range test (alpha = 0.10) was used to analyze the effect of entry.

Results

Overall, for the fourteen entries planted in both May and June, the planting date (PD) by entry (E) interaction was significant for marketable yield, non-marketable yield, core base width, and the percent of the head volume occupied by the core (Table 3). The effects of PD and E on factors (e.g., total yield, head diameter, core length) were largely independent.

Estimated average marketable yield (ton/A) ranged from 9 -31 in spring and 4-27 in summer. Estimated total yield ranged from 16-33 in spring and 4-29 in summer. Small changes in marketable and total yield due to planting date led to shifts in the rank order of entries for yield within a planting date (Table 9). Examples of this shift in rank order in marketable yield due to planting date include: i) entry #13 being ranked 1st in marketable yield in spring and 3rd in summer, ii) entry #7 being ranked 2nd in marketable yield in spring and 2nd in summer, and iii) entry #12 being ranked 3rd in marketable yield in spring and 1st in summer. Mostly similar results were found for the effect of planting date when tested within individual entries (Table 8). Individual entries were unchanged, moderately changed, or significantly changed by different planting dates (Table 9). For example, planting in June versus May significantly changed at least five of eight head and core traits evaluated statistically in three genotypes. In contrast, planting in June versus May significantly changed 0-1 of eight head and core traits evaluated statistically in two genotypes. Taken together, these data may assist growers in matching varieties and planting dates more successfully.

The effect of planting date was significant in all variables studied, except core length (Table 3). Yield (marketable, non-marketable, total), head size, and core size tended to be greater in the May compared to the June planting (Table 4). However, the effect of planting date on marketable yield, non-marketable yield, and core base width were specific to entry (see PD x E discussion above). Differences between planting date in head and core size were numerically small but statistically significant (Table 4).

Interpretation

Variety selection is an important management decision. The need to meet harvest schedules, often with sequential plantings, complicates variety selection in processing cabbage production. Research-based information on how a variety responds to changes in planting date, for example, may assist growers in identifying varieties largely unaffected by planting date or in selecting varieties specifically for early or late planting.

The 1999 season was characterized for above average temperatures and below average rainfall (Table 2). Moisture deficits persisted throughout crop development in these studies. For example, rainfall was well below average for the period during which the June-planted fresh market type crop developed, especially in the first and last 25 days of the 100-day period described in Table 2.

Planting date and entry had statistically significant effects on nearly all of the factors studied. Some changes (e.g., decline in yield, changes in maturity) in a number of varieties following later planting or differences among some entries within a planting may be may be very important to growers and processors. Growers and processors are encouraged to review the following tables to identify entries with yield, head, core, and maturity characteristics that will be optimal for their unique situation.

For more information on this project or report, please contact Matt Kleinhenz (ph. 330-263-3810; E-mail kleinhenz.1@osu.edu).

Table 1. Processing cabbage genotypes planted at the Vegetable Crops Research Branch in Fremont, OH on May 11 and June 18, 1999.

Entry	#	Evaluated in 1998?	Date Planted	Date Harvested	# of Days to Harvest
Almanac	1	no	11-May	26-Jul	76
			18-Jun	26-Aug	69
Balbro	2	no	11-May	26-Jul	76
			18-Jun	19-Aug	62
Blue Thunder	3	no	11-May	7-Sep	119
			18-Jun	18-Oct	122
Bravo	4	yes	11-May	23-Aug	104
			18-Jun	18-Oct	122
Fortress	5	no	11-May	19-Aug	100
			18-Jun	18-Oct	122
Genesee	6	yes	11-May	7-Oct	149
			18-Jun	18-Oct	122
Geronimo	7	no	11-May	26-Aug	107
			18-Jun	18-Oct	122
Hinova	8	yes	11-May	7-Oct	149
			18-Jun	19-Oct	123
Huron	9	yes	11-May	18-Oct	160
			18-Jun	19-Oct	123
Mentor	10	no	11-May	18-Oct	160
			18-Jun	19-Oct	123
NIZ 95-23	12	no	11-May	30-Aug	111
			18-Jun	18-Oct	122
Score	13	yes	11-May	30-Aug	111
			18-Jun	18-Oct	122
Strukton	14	yes	11-May	18-Oct	160
			18-Jun	19-Oct	123
Upton	15	yes	11-May	7-Oct	149
			18-Jun	19-Oct	123

Table 2. Climatic data for processing cabbage experiments planted at the Vegetable Crops Branch in Fremont, OH in 1999 on May 11 (Planting 1) and June 18 (Planting 2).

	Average Temp. (F)		------ Precipitation (in.) -------		
	High	Low	Actual	Normal	deficit
Planting 1					
May 11 - June 5 (25 d)	74.5	49.2	2.66	3.4	- 0.74
June 6 - July 26 (50 d)	85.9	58.9	4.71	6.5	- 1.79
July 27 - Aug. 21 (25 d)	83.0	56.7	1.92	3.0	- 1.08
Total			9.29	12.9	- 3.61
Planting 2					
June 18 - July 13 (25 d)	84.1	57.9	0.83	3.3	- 2.47
July 14 - Sept. 2 (50 d)	83.5	57.1	4.82	5.6	- 0.78
Sept. 3 - Sept. 28 (25 d)	79.7	46.3	0.31	2.7	- 2.39
Total			5.96	11.6	- 5.64

Irrigation was supplied on July 1 (0.10 in.) and July 16 (0.50 in.).

Table 3. Influence of planting date and entry on yield and head traits for fourteen genotypes of processing cabbage planted on May 11 and June 18, 1999 at the Vegetable Crops Research Branch in Fremont, OH.

Source	df	yield (ton/A)			head diameter (cm.)		core		
		marketable	non-marketable	total	polar	equatorial	length (cm.)	base width (cm.)	volume as % of head volume
		Pr > F							
Planting Date (PD)	1	<0.0001	0.0012	< 0.0001	<0.0001	0.0003	0.1471	<0.0001	<0.0001
Entry (E)	13	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0017	<0.0001	<0.0001
PD x E	15	0.0038	< 0.0001	0.1377	0.1278	0.3395	0.4418	<0.0001	<0.0001

Table 4. Influence of planting date on yield and head traits for fourteen genotypes of processing cabbage planted at the Vegetable Crops Research Branch in Fremont, OH in 1999.

Planting Date	N	yield (ton/A)			head diameter (cm.)		core		
		marketable	non-marketable	total	polar	equatorial	length (cm.)	base width (cm.)	volume as % of head volume
May 11, 1999	56	20.2 a	4.24 a	24.5 a	17.7 a	16.9 a	7.26 a	3.48 a	0.82 b
June 18, 1999	55	13.9 b	2.60 b	16.5 b	15.9 b	15.7 b	7.02 b	3.29 b	0.98 a
$L.S.D._{(0.10)}$		1.76	0.82	1.89	0.35	0.53	0.27	0.06	0.04

Table 5. Yield and head characteristics of processing cabbage varieties planted on May 11, 1999 in Fremont, OH.[1]

Cultivar	Entry #	Weight of individual heads[3]	Estimated Yield[2]			% by weight				Head[3]		Core[3]	
			Mrktbl	Non-mrktbl	Total	Mrktbl	split	rot	<5 in	Polar Diam.	Eqtrl Diam.	Length	Base Width
		kg	Ton/A			%				cm			
Almanac	1	1.8	22.4	0.0	22.4	100	0	0	0	17.4	16.6	6.8	3.3
Balbro	2	2	22.6	2.2	24.8	91	0	9	0	18.6	16.0	6.8	3.0
Blue Thunder	3	2.1	15.2	5.8	21.0	72	3	24	1	17.9	16.6	7.6	4.0
Bravo	4	2.4	13.4	14.1	27.5	49	1	50	0	17.4	17.4	7.4	3.4
Fortress	5	2	15.0	0.7	15.7	86	2	0	12	16.6	17.0	7.7	2.7
Genesee	6	2.3	8.9	18.0	26.9	30	14	42	14	18.0	16.8	6.9	3.5
Geronimo	7	2.6	29.1	3.2	32.3	90	0	10	0	17.9	18.5	6.8	3.4
Hinova	8	2.4	21.2	2.7	23.9	88	1	11	1	18.0	17.0	7.5	3.2
Huron	9	2.1	21.1	1.3	22.4	93	0	5	2	17.0	17.1	7.6	4.7
Mentor	10	2.4	20.6	4.2	24.7	82	0	17	1	17.0	17.7	6.8	3.9
NIZ 95-23	12	2.5	27.8	0.9	28.7	97	0	2	1	18.4	17.4	7.5	3.0
Score	13	2.8	30.9	2.4	33.3	94	0	6	0	18.5	18.2	7.2	3.4
Strukton	14	1.6	14.4	2.6	16.9	93	0	20	3	17.3	14.4	7.5	3.8
Upton	15	2.1	20.7	1.5	22.1	90	1	5	4	17.1	16.1	7.3	3.3
$DMRT_{(0.10)}$		0.7	8.2	3.7	8.5					1.5	2.3	1.2	0.3

[1] Each value is the average of four replications.

[2] Harvested 20 consecutive heads per plot regardless of condition. See project description for calculation of estimated yield. Heads graded as marketable are > 5 in. and are not split or rotten.

[3] Average weight and measurements of 10 marketable heads.

Table 6. Yield and head characteristics of processing cabbage varieties planted on June 18, 1999 in Fremont, OH.[1]

Cultivar	Entry #	Weight of individual heads[3]	Estimated Yield[2]			% by weight				Head[3]		Core[3]	
			Mrktbl	Non-mrktbl	Total	Mrktbl	split	rot	<5 in	Polar Diam.	Eqtrl Diam.	Length	Base Width
		kg	Ton/A			%				cm			
Almanac	1	1.5	16.1	1.0	17.1	90	2	3	6	15.8	14.7	6.5	3.0
Balbro	2	1.3	6.6	4.9	11.5	45	37	2	16	16.1	14.1	6.6	2.9
Blue Thunder	3	1.7	7.7	7.2	14.9	47	2	44	8	14.8	16.0	7.7	3.6
Bravo	4	1.9	8.9	11.3	20.1	47	3	47	4	15.1	17.1	7.3	3.9
Fortress	5	1.8	14.8	1.3	16.1	83	0	7	9	15.8	16.9	7.3	3.2
Genesee	6	2.0	16.0	1.5	17.5	80	0	8	12	17.0	16.6	6.4	3.7
Geronimo	7	2.2	21.1	4.0	25.1	81	0	16	3	16.0	18.3	6.1	3.4
Hinova	8	1.8	16.0	1.0	17.0	90	0	5	4	15.9	15.7	6.9	2.7
Huron	9	0.9	3.9	0.0	3.9	53	0	0	47	14.3	13.0	7.7	3.2
Mentor	10	1.9	17.6	0.8	18.4	95	0	5	0	15.6	15.3	6.9	2.9
NIZ 95-23	12	2.6	27.0	2.2	29.1	92	0	7	1	19.2	18.3	8.9	3.5
Score	13	2.1	18.5	0.7	19.2	92	0	3	6	16.9	16.6	6.0	3.8
Strukton	14	1.2	9.0	0.0	9.0	75	0	0	25	14.8	12.9	7.5	3.4
Upton	15	1.4	9.8	0.0	9.8	82	0	0	18	14.9	13.9	6.4	2.9
$DMRT_{(0.10)}$		0.6	7.7	3.7	8.7					1.7	2.5	1.2	0.3

[1] Each value is the average of four replications.

[2] Harvested 20 consecutive heads per plot regardless of condition. See project description for calculation of estimated yield. Heads graded as marketable are > 5 in. and are not split or rotten.

[3] Average weight and measurements of 10 marketable heads.

Table 7. Average yield and head characteristics of processing cabbage entries planted on May 11 and June 18, 1999 in Fremont, OH.[1]

Cultivar	Entry #	Weight of individual heads[3]	Estimated Yield[2]			% by weight				Head[3]		Core[3]	
			Mrktbl	Non-mrktbl	Total	Mrktbl	split	rot	<5 in	Polar Diam.	Eqtrl Diam.	Length	Base Width
		kg	Ton/A			%				cm			
Almanac	1	1.6	19.3	0.5	19.8	95	1	2	3	16.6	15.6	6.6	3.2
Balbro	2	1.7	14.6	3.6	18.2	68	19	6	8	17.3	15.1	6.7	2.9
Blue Thunder	3	1.9	11.5	6.5	18.0	59	3	34	5	16.4	16.3	7.7	3.8
Bravo	4	2.1	11.2	12.7	23.8	48	2	48	2	16.3	17.3	7.3	3.7
Fortress	5	1.9	14.9	1.0	15.9	85	1	4	11	16.2	16.9	7.5	3.0
Genesee	6	2.2	12.5	9.8	22.2	55	7	25	13	17.5	16.7	6.6	3.6
Geronimo	7	2.4	25.1	3.6	28.7	85	0	13	2	17.0	18.4	6.5	3.4
Hinova	8	2.1	18.6	1.9	20.5	89	0	8	3	16.9	16.4	7.2	2.9
Huron	9	1.5	12.5	0.7	13.2	73	0	3	25	15.7	15.0	7.7	3.9
Mentor	10	2.1	19.1	2.5	21.6	89	0	11	1	16.3	16.5	6.8	3.4
NIZ 95-23	12	2.6	27.4	1.6	28.9	95	0	5	1	18.8	17.8	8.2	3.2
Score	13	2.5	24.7	1.6	26.3	93	0	4	3	17.7	17.4	6.6	3.6
Strukton	14	1.4	11.7	1.3	13.0	84	0	10	14	16.1	13.6	7.5	3.6
Upton	15	1.8	15.3	0.8	16.0	86	1	3	11	16.0	15.0	6.9	3.1

[1] Each value is the average of four replications.

[2] Harvested 20 consecutive heads per plot regardless of condition. See project description for calculation of estimated yield. Heads graded as marketable are > 5 in. and are not split or rotten.

[3] Average weight and measurements of 10 marketable heads.

Table 8. Influence of planting date on yield and head traits for fourteen genotypes of processing cabbage planted on May 11 and June 18, 1999 at the Vegetable Crops Research Branch in Fremont, OH. An asterisk ("*") indicates that planting date significantly effected the variable listed within the genotype according to the Fisher Least Significant Difference test ($\propto$ = 0.10).

Entry		N	yield (ton/A)			head	core			# of traits of 8 effected by planting date
			marketable	non-marketable	total	polar	diameter (cm.) equatorial	length (cm.)	base width (cm.)	volume as % of head volume	
Almanac	1	8				*					1
Balbro	2	8	*	*	*	*	*		*	*	7
Blue Thunder	3	8	*		*	*			*	*	5
Bravo	4	8	*			*			*	*	4
Fortress	5	8							*	*	2
Genesee	6	8		*	*	*			*	*	5
Geronimo	7	8									0
Hinova	8	8		*		*			*		3
Huron	9	8	*	*	*	*	*		*	*	7
Mentor	10	8		*	*	*	*		*	*	6
NIZ 95-23	12	8							*	*	2
Score	13	8	*		*			*		*	4
Strukton	14	8			*	*	*		*	*	5
Upton	15	7		*					*		2
# comparisons of 14 significant			5	6	7	9	4	1	11	10	

Table 9. Processing cabbage entries ranked from high to low in average marketable yield (ton/A) after planting on May 11 and June 18, 1999 in Fremont, OH.

Rank	Entry		Entry	Rank		Change With Summer
	Spring	Summer		Spring	Summer	
1	13	12	1	5	5	0
2	7	7	2	4	13	-9
3	12	13	3	10	12	-2
4	2	10	4	13	11	2
5	1	1	5	11	8	3
6	8	8	6	14	7	7
7	9	6	7	2	2	0
8	15	5	8	6	6	0
9	10	15	9	7	14	-7
10	3	14	10	9	4	5
11	5	4	12	3	1	2
12	14	3	13	1	3	-2
13	4	2	14	12	10	2
14	6	9	15	8	9	-1

Table 10. Plant characteristics and pest damage for processing cabbage entries planted on May 11 and June 18, 1999 in Fremont, OH.

Cultivar	Entry #	Planting 1=early 2=late	Frame[1] Upright-ness	Frame[2] Size (1-5)	Head[3] Shape	Shatter[4] Rating (1-3)	Internal[5] Density (1-5)	Internal[6] Color	Midrib[7] Size (1-5)	Black Rot[8]	Thrips[9] Rating (1-5)	Thrip Damage Trim Wt (g)
Almanac	1	1	S	3.0	R	2.0	2.0	CR	3.0	-	2.0	0.5
		2	S	4.3	R-T	3.0	3.0	CR-Y	3.8	-	2.0	0.7
Balbro	2	1	S	4.3	R	2.0	1.8	CR	2.8	-	2.3	0.6
		2	S-V	4.5	E-P	3.0	2.8	CR-Y	2.8	-	2.3	0.7
Blue Thunder	3	1	S	3.0	R-P	1.0	1.0	CR-W	2.8	+	1.8	0.8
		2	S-T	3.5	R-F	3.0	2.0	CR-Y	2.8	+	2.3	0.8
Bravo	4	1	S-V	3.0	R	2.5	2.5	CR-W	2.8	+	0.5	0.1
		2	S-V	3.3	R-F	2.8	2.5	CR-W	1.8	+	2.5	0.9
Fortress	5	1	U	3.0	R-P-F	1.0	2.0	CR	2.8	-	2.5	0.9
		2	S	3.3	R-F	3.0	2.0	CR-Y	2.8	-	3.5	1.9
Genesee	6	1	U-S	4.0	R-P	3.0	1.0	CR-W	2.3	+	4.6	2.9
		2	S-T	4.3	R-P	2.5	1.5	CR	2.8	-	2.8	1.8
Geronimo	7	1	S	3.0	R-F	1.5	2.0	CR-W	2.3	-	2.5	1.5
		2	V	3.8	R-F	3.0	2.0	CR-Y	2.3	+	3.8	2.3
Hinova	8	1	U-S	3.3	R-P	2.0	1.0	CR-W	3.0	+	3.6	3.0
		2	S	3.5	R-P	1.0	1.3	CR-W	2.8	-	2.3	1.4
Huron	9	1	U-S	3.3	R-O	1.3	2.0	CR-Y	1.3	-	3.5	2.0
		2	U	4.8	O	1.3	4.8	CR-Y	2.3	-	2.4	0.7
Mentor	10	1	U	4.3	R-P	2.5	1.0	CR-W	2.0	+	4.5	3.1
		2	S-T	4.3	R-P	2.0	1.3	CR-W	3.0	-	2.9	1.4
NIZ 95-23	12	1	U	2.3	R-E	1.0	1.3	CR	2.0	-	2.9	1.7
		2	U-V	3.0	R	2.8	3.0	CR	2.5	-	2.5	1.8
Score	13	1	S-V	2.5	R-P	2.3	1.3	CR-W	2.0	-	3.5	1.8
		2	T-V	3.8	R-P	2.5	2.0	CR-Y	3.3	-	2.8	1.8
Strukton	14	1	U	4.3	P-E	2.3	1.0	CR	1.8	+	4.8	2.2
		2	U	5.0	R-T-E	1.0	3.0	CR	2.8	-	3.3	0.9
Upton	15	1	U	4.3	R-F	1.0	1.3	CR-W	2.3	-	4.0	2.8
		2	S	3.3	R-F	1.0	1.3	CR-Y	2.7	-	3.3	2.0

[1]Uprightness: U=upright, S=slightly tipped, T=tipped, V=very tipped
[2]Frame size: 1=large, 5=small
[3]Shape: R=round, T=teardrop, E=egg, P=pointed, O=odd shape
[4]Shatter: 1=tightly wrapped, 3=outer leaves easily break and peel off
[5]Density: 1=dense, 5=open air space within head
[6]Internal color: W=white, CR=cream, Y=yellow
[7]Midrib: 1=small, 5=large
[8]Black rot: + =present, - =no rot
[9]Thrips: 1=none, 2=on outer leaves, 3=several layers deep, 5=damage more than 2" deep

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